

12.0 APPENDICES

12.1 MONITORING MATRIX

Field #	Project Name	Collected By	Frequency	Period	RM From	To	Date Span	Ending	Sample Matrix	Pearliders	Contact	% Noobs*	Data Access	Availability	Time Frame Access	
1	DSSC Daily Hydrologic Summary Report	USGS/SDIC, NYCEP, Kinne Clark Inc.	daily/hourly	Present	90	330	1945	Present	Daily flow, NYC storage, Estuary chloride & location	Chloride	Buried fromm	Mottage, Tenthill, Leigh River at Berlin & Easton, Saylorsville, Phila and Potts. Also Hard Copy and Computer file	7	Daily		
2	USGS Surface Water Quality Stations Network	USGS/NDOH	4wyr		30	330	1967	Present	Water	Disolved nutrients, fecal coliform, heterotrophic cells, pesticides, PCBs, nitrogen, phosphorus and TOC	Bd Reser (609) 771-380	Bd Reser (609) 771-380	Long term data on NY Dept of Environ. Data & % capacity at the Republican, Cannonsville, Neversink & Rondout. Delaware River Basin Network.	Hard Copy	1 week	
3	USGS Groundwater Monitoring Network	USGS	Monthly		60	300	1974	Present	Water levels	Ground water level measurements	Kirk White (610) 767-3006	USGS routinely monitors GW levels in at least 8 upland monitoring wells contributing to Hard Copy	Hard Drive	2-4 weeks		
4	Oyster Spat Survey	DNREC	Seasonal	May-Sept	0	48	1974	Present	Abundance indices	Abundance of year spat	Richard Cole (302) 739-4782	The dredge line one of the few.	Computer File	?	?	
5	Shorebird migration survey	NJDEP/DNREC	Yearly	May-June	0	20	1986	Present	Counts	Aerial survey of abundance/species	Kathleen Clark (609) 228-2103	Kathleen Clark (609) 228-2103. Weekly aerial survey of beaches, in May, Cape May to Cohansey (NJ) and Woodland Beach, DE to Cape Henlopen, DE	Computer file/Logs	?	summarized data available, raw data not given out	
6	Age/Predator Survey	NOAA/NMFS NEFC	2-3yrs	May-Oct	6	30	1986	Present	Tagging Study	Tagging study, Relative Abundance and Cession of selected sharks	Nancy Kohler (401) 762-3200	Gillnetting & tagging in lower bay near sandbar at east entrance, utilizing long lines and gill nets (75' by 10' by 4' stretch mesh) day. On sampling at 2 stations in the Bay (See Appendix N & V).	Computer file	Desk	6 months	
7	Beach Seine Survey/Striped Bass young of the year	NJDEP	23-mo and 3wyr	Aug-Oct	54	133	1980	Present	Census	Counts, Relative Abundance estimates	Tom Barnum (609) 747-8000	Juvenile fish survey of artificial island to Trenton to 16 fixed stations 2mo and at random stations. 3 yr. Pantry Stress survey index. Amer. Shad, Stell. and Alewife	Computer file	desk	annually	
8	Burrows & Biogenic Sediment Census	Del Nature Society	Ongoing	Jul-Aug	58	133	1981	Present	Census data	Vessel strings, Relative abundance	Tom White (321) 2239-2320 ext. 104	See Appendix G3. Burrow locations. Stations sampled monthly, mid-November.	See Appendix G3. Burrow locations. Stations sampled monthly, mid-November.	?	?	
9	Trawl Survey	NJDEP	5oyr	May-Sept	4	58	1991	Present	Census	Abundance estimates, young of the year	Jeffrey Norman (609) 422-3230 ext. 104	Delaware Bay - Cape May to Salem, NJ. Sampling at 11 sites in NJ. Delaware Bay & Estuary with float or trawl.	Computer file/Excel	Hard Drive	3 months	
10	Juvenile Fish Survey	DNREC	Monthly/May	Apr-Oct	12	72	1980	Present	Census	Abundance estimates, young of the year	Stewart Michaels (302) 738-4762	16 Bottom Trawl CD can't cover in Delaware waters 1989 - present sampling from Bay (See Appendix N & V).	Computer file	Internet	present	
11	Fisheries Landing Data	NOAA NMFS DNREC, NJDEP	Monthly	Jan-Dec	4	72	1980	Present	Catch Data	Landing Data	William Lembeck (312) 553-2887	Ready Stand up Wilmington area.	computer file, ASCII	Hard Drive	present, continuous	
12	Water Use Inventory	DRBC	Annual	0	330	1987	1995	Water Usage	Identification	David Days (609) 883-3230 ext. 240	Update inventory of several thousand lots and tanks within the Delaware River Basin.	Computer file	STORET	2-3 months		
13	Delaware Estuary Boat Run	DNREC/DRBC	March-Nov. 12yrs	Mar - Nov	31	128	1967	1997	Water	Feas. conformities, conventional nutrients, VOCs, radiological algae	Ed Santoro (609) 988-3283	Samples collected at 22 mid-channel stations, all low salinity. Radiodischarge is based annually. Subsurface samples collected from bottom N. to mouth of Delaware Bay.	Computer file	Disk	1 year	
14	Toxics Program	DRBC	Yearly	60	117	1983	Present	Tissue	79 PCB congeners, metals, pesticides	Dr. Thomas F. Kline (609) 883-3450	Five stations surveyed in the Delaware Estuary. Three stations within the non tidal river. One additional station affected by dredging during 2004.	Computer file	Disk	1 year		
15	NAWQA	USGS	Monthly/Fixed Sites	133	330	1999	Water Issue	Sediment	Inorganic/organic, biological, ecological	Jeffrey M. Tavel (609) 711-9533	Five stations surveyed over 3 years and resampled every 5-7 years. Study and Delaware River & Coastal Plain to head of the Bay. Appendix B-34 major ones are located in B5.	Computer file	Spot	3 months		
16	Stats & Trends	NOAA	Biennal	0	48	Present	Present	Tissue	Mussels & Oysters, tissue analysis, sediment grain size.	Gunnar J. Laurenti (301) 713-3028 ext. 152	Up to eight locations in Delaware Bay on alternate years. See Appendix B-6.	Computer file	Disk	1 year		
17	Marine Fish Survey	FDA	Annual	1989	0	160	Present?	Present	Fish Tissue	Fish Tissue	Stewart Michaels (302) 738-4762	Two sampling of modified fish and shrimp for human health. Organochlorines and organic chlorine free substances, dioxin-like PCBs and DDTs and furans. This information is used at set action levels and criteria for freedom.	Computer file/ASCII	disk	present	
18	Bottom Trawl Fisheries Survey	DNREC	Monthly	Mar - Nov	0	60	1986 and 1999	Present	Tissue	Fish Tissue	Stewart Michaels (302) 738-4762	Contractors in Bad Endless, Oceans, Egg Rock, Catches. Also limited sampling in 1992?	Computer file	disk	?	?
19	Repro. Study	NJDEP	Regular	Mar - Jul	0	60	1988	Present	Tissue	Polyclonal contaminants in eggs, blood	Stewart Michaels (302) 738-4762	Contractors in Bad Endless, Egg Rock, Catches. Also limited sampling in 1992?	Computer file	disk	present	
20	Mid-Atlantic Integrated Assessment (MAIA)	NOAA	Annually	Sept	0	133	1997	1998	Water, Benthic Tissue	Sediment toxicity and contaminant levels, benthic biological studies and water quality studies	Dr. David Hammedi (301) 713-3034	92 stations in Estuary and Salem and Schuylkill Rivers and small estuaries. Chesapeake Bay, Blackwood Creek, New Jersey. (See Appendix H). Fish issue will be collected during the 1998 survey.	Computer file	Internet website	week to week	
21	Natl Estuarine Reserve Sites (NERRS)			22	38								2 sites Cohansey Estuary, 2 sites St. Jones			
22	ANINET	NJDEP	15 yrs	Jan-Dec	10	100	1995	Present	Census	Biological impairment ratings and biological studies	Afghan Komodoff (609) 224-2427 ext. 104	Sample collection in 20 watershed management areas around the state. Data were sent into watershed areas and 30 sampling sites (See Appendix A-10). All sites above head of tide.	Computer file, Word Perfect, GIS	Hard Drive	Present	
23	All Coastal Fisheries Corp. Mgmt. program	USFWS/DEEP, DNREC	?		20	160	1985	Present	Commercial catch, tagging	Catch record at port and age studies	Pete J. Hinrichs (609) 748-2000	Catch tag/lethargy frequency data on landings of selected species. Refer to Appendix D for info.	Hard Copy	disk	?	
24	Modeling Calibration Studies	USGS/SDIC	Ongoing	170	200	1989	Present	Water	Species	Karen Nagel (609) 383-9300	Studies have included the rate of rakes, numbers and BOD, percent biomass and others.	Land use and cover types	Hard Copy			
25	Significant habitat mapping	USFWS, DEEP, DNREC	?	0	60	1994	Present	Mapping	Land use and cover types	Fish & Wildlife (609) 664-310	Studies have included the rate of rakes, numbers and BOD, percent biomass and others.	Land use and cover types	Hard Copy			
26	Natl GAP Project:	USFWS/BRD/DEPA	?	0	60	1982	1993	Mapping	Land use and cover types	Fish & Wildlife (609) 664-310	Studies have included the rate of rakes, numbers and BOD, percent biomass and others.	Annual counts	Land use and cover types	Hard Copy		
27	GIS Mapping	NJDEP	Ongoing	0	330	1986	2002	Mapping	Land use and cover types	Laura and Thornton (609) 384-2423	Survey in riparian areas and along rivers and streams. Includes the Delaware River, NJ, DE, and others.	Land use and cover types	Hard Copy			
28	DVRPC Mapping	DVRPC	Ongoing	0	90			Mapping	Land use and cover types	Barry Raymond (215) 592-1831	Land use mapping from low aerial flights	Computer file	STORET	present		
29	1st Shorebird Survey	Center for Conservation Sciences	Annually	Apr-Oct	0	30	1987	Present	Aerial survey	Annual counts	Brian Harrington (508) 224-6821	Predictive surveys limited, designated sites.	Computer file	disk	present	
30	Turtle Survey	PADEP/DRBC	6wyr	Quantity at minimum	80	100	1987	Present	Water	Observations, numbers, means, variances, organic compounds	Steve DeWitt (609) 383-9300 ext. 103	Survey of turtle activity in Fall, Winter, Spring & June-July. X-racks in Fall, Winter, Spring in Pennsylvania tributaries to Delaware River above the head of the.	Computer file	STORET	present	

Field#	Project Name	Collected By	Frequency	Period	RM From	To	Data Span	Ending	Sample Matrix	Parameters	Contact	"Notes"	Data Access	Availability	Time Frame/Access	
32	Upper Bay Study	NDEP/DRBC	1/Yr	Apr-Oct	133	233	Present		Water	Concentrations, infauna, metals, volatile organic compounds, pesticides, and PCBs.	Tan Verma (609) 723-0427	See Appendix D for parameter list. Sampling along mainstem and tributaries.	Computer file; hard copy	Microsoft Access	present	
33	Benthic Assemblages and habitat studies	PADER/DRBC	5 year	1x5yr	10	130	1987	Present	Benthic assemblages	Gary Watters (610) 832-5047	See Appendix F	Computer file; hard copy	Microsoft Access	present		
34	Bridge Scour Survey	USGS/PenDOT	Annual	Yearly	68	330	1987	Present	Bridge Scour	Patricia Tals (717) 730-6814	Thalweg monitor sites. 13 USGS sites and 5 research sites.	Hard copy	customized data	?		
35	WQ Studies in Delaware	USGS	Every 15 min.	Day	54	100	? Present		WQ Flow	High Diving/Buoys	Stations on Delaware at Kenton, Bear Franklin Bridge, Fort Mifflin, Chester, Reedy Island, Bay, Assessor in Schuylkill River/monitran.	Computer file; ASCII	base	Hard Drive	present, continuous	
36	Semic-River Monitoring Program	DRBC/NPS	Monthly		210	330	1984	Present	Water	Water chemistry, flow, ecological	Beth Lueckeborn (609) 833-1040	Upper basin monitoring, from Hancock, NY to the Delaware Water Gap.	Computer file; hard copy	Microsoft Access	present	
37	Specific Conductance Monitoring	USGS	1 per hour	Jan-Dec	55	90	1985	Present	Water	Chloride levels in the Estuary	Dave Schreiber (610) 478-6038	Specific conductance data is converted by DRBC to chloride and location of 7 day average. 250 mm isochore is determined at a daily basis stations 85-90 in R., P., Mill Creek, Chesapeake City and New Ward.	Computer file; ASCII	base	Hard Drive	present, continuous
38	USACE Feasibility Study	USACE			210	330	Present			Christine DeVille	Sampling in upper Delaware River. Parameter evaluation system and indoor test reduction.	Computer file; hard copy	base	Hard Drive	present	
39	Delaware Bay Benth Program	DNREC	1x2/2m		6	30	1985	Present	Benthic assemblages	Jeff Tresman (302) 273-4782	Preliminary confirmations of artificial reef sites in Delaware Bay. permitted sites from Collier's Survey to date. IE.	Hard Copy	Hard Copy	4 months		
40	DE Fishesles Sampling Study	DNREC	4Ximo		68	104	Present		Spanning Study	Craig Sherry (302) 739-4431	Electro fishing survey from Nanticoke Bridge to Big Tim's Creek, NJ. 20 stations	Computer file; Disk	base	Disk	?	
41	DE Fishesles Stagen Study	DNREC	4Ximo (Jun-Dec)	June-Oct	58	62	Present		Tagging Study - DNA, Age & Abundance, Census.	Craig Sherry (302) 739-4431	Electro sampling sonic & streamer tagging. DNA samples, aging, streamer study fish collections from Pea Patch to South Experimental reef. 10' SQ mesh. 1,200 long.	Computer file; D-base	base	disk	present	
42	DE Tran Survey	DNREC	3ximo	Mar-Dec	60	110	Present		Census	Stewart McHugh (609) 738-2472	Bottom survey adult fishes collected with 20' trawl.	Computer file; ASCII	base	disk	present	
44	DE Surgeon Study	DNREC	3ximo	Jul-Oct	54	61	Present		Tagging	Craig Sherry (302) 739-4431	Bottom gill netting, sonic and streamer tagging. DNA sampling, aging, streamer study fish collections from Pea Patch to Salem.	Computer file; D-base	base	disk	present	
45	DE Sediment Bass Study	DNREC	4ximo	Mar-Dec	68	110	Present		Census, Spawning	Craig Sherry (302) 739-4431	Bottom gill netting, sonic and streamer tagging. DNA samples, aging, streamer study fish collections from Pea Patch to Salem.	Computer file; D-base	base	disk	9 months	
46	Marine Water Quality Survey	NDEP	Year monthly to quarterly		4	48	Present		Biogeological sampling	Robert Cornell (609) 738-2400	Bottom trawl survey 200 stations sampled in Delaware Bay. Frequency of collection varies by a minimum of 1 day. (See Appendix L & I for additional information)	Computer file; ASCII	base	disk	present	
47	Californian Creek Watershed Study	NW Author Soc., NPS, WOCO, NRCS, SCNSD	Weekly	Jul-Aug	303	365	12	Ended	Bottom	Lois Daruff McKeon (609) 746-2000	Numerous stations in the Californian watershed sampled weekly. (See Attachment M for work plan)	Computer file; ASCII	base	disk	present	
48	Marine Water Monitoring	NDEP	Quarterly	Jan-Dec	0	48	1989	Present	Bottom	Robert Cornell (609) 738-2400	Bottom trawl survey 100 stations sampled in Bay.	Computer file; ASCII	base	disk	present	
49	WWTP Monitoring	PADER/ DRBC	Monthly/Bimonthly, Quarterly	Jan-Dec	54	133	1987	Present	Oxygen/nitrogen/seas.	Ed Sartore (609) 983-5047	See Appendix O and Q for information. A list of facilities within the study area is presented on Appendix O2.	Hard Copy	base	STORET	present	
50	Water Snapshot	Over 70 groups coordinated by DRBC	4.5yimo.	Annual	40	330	1996	Present	Water	Concentrations, Nutrients, Metals, Selected Organics, TSS, BOD, P, pH	950/12/268	See Appendix O1 and Q2 for information. A list of facilities within the study area is presented on Appendix O2.	Computer file; ASCII	base	disk	present
51	Smithfield Recreational Survey	DNREC	5 year cycle	May-Sep	0	78	1989	Present	Water	Background sampling - Enteric-2002s and total coliform	950/12/268	Seven stations in Bay/Ocean. Since 1992 DRBC switched to systematic random sampling. All major bays in Del. Bay are sampled since 1994. All major bays in Del. Bay are sampled.	Hard Copy	base	STORET	24 weeks
52	NDEP ambient monitoring program	NDEP/ USEPA, USGS	5 year cycle	1-1.5yrs	60	330	1975	1981	Sediment	Held Konradofsky (609) 982-4728	A 10 minute station in each 2nd order stream along the NJ side of Delaware.	Computer file; ASCII	base	disk	present	
53	Univ of Delaware Research Cruises	Univ. of Del.	Periodic	Jan-Dec	0	130	1978	Present	Water	Dr. Jonathan Sharp (302) 442-4239	Concentrations, nutrients, trace elements, dissolved organic matter and particulate organic matter.	Computer file; ASCII	base	disk	present	
54	Estuary Enhancement Program	PSCE&G	Toms Point Beach Same Znto	April-May-Oct	0	96	1994	Present	Bottom mapping, habitat assessment, dredging	Ken Straight (866) 876-6293	Trawl surveys for fish abundance. See Appendix SA. Fish index project for 5 sites to restoration and the marsh areas are presented in Appendix C.	Computer file; ASCII	base	disk	present	
55	Juvenile Survey	DNREC	7amo	Apr-Oct	0	60	Present		Census	Steven Moore (302) 34-0782	Young of the year and overwinter collections using a 16' trawl.	Computer file; ASCII	base	disk	present	
56	Pennsylvania Water Quality Network (WN)	PADEP	Monthly	Jan-Dec	80	305	1981	Present	Water/Tissue	Tammy Sauter (717) 740-4648	9 years of (including mid 90's) water use analysis. 14 sites below Delaware Basin, above the head of the river, 6 sites central Delaware Basin, 11 sites upper Delaware Basin.	WWS Office in M. Holley, During flood events, WWS uses precipitation traps and USGS stream flow to forecast runoff stages at USGS gauging stations & with available streamflow data placed on NOAA weather radio and internet locations for stations.	base	disk	present	
57	USGS Surface Water Flow Monitoring	USGS	Every 15 mins.	Year Round	0	330	Variabile some stations vary 190	Present	Flow	Randy Dunn (609) 34-0782	Real time data available on NWS in NJ, NY, PA. Archived data available from Internet and USGS Office. Lehigh & Ingles locations for stations. Non-ideal flow and tributaries.	Computer file; ASCII	base	disk	present	
58	National Weather Service Flood Forecasting Network	National Weather Service	As Required	Year Round	0	330	Present		Flood/Rain Stages	NWS Office in M. Holley, NJ, Burlington, NJ	During flood events, NWS uses precipitation traps and USGS stream flow to forecast runoff stages at USGS gauging stations & with available streamflow data placed on NOAA weather radio and internet locations for stations.	Computer file; ASCII	base	disk	present	
59	National Weather Service Precipitation	National Weather Service	Hourly	Year Round	0	330	Variabile some stations since 1990	Present	Daily & hourly precipitation	Net Ordnac Data Ctr., Annette, NC, Internet	Data is passed to weather service offices in Maryland, NJ or throughout NY via satellite, radio, reporting on pages to nature observers. Station locations are by id. & ring about 100 stations throughout Basin	Computer file; ASCII	base	disk	present	

Field1	Project Name	Collected By	Frequency	Period	RM From	To	Date Span	Ending	Sample Matrix	Parameters	Contact	Notes	Data Access	Availability	Time Frame Access	
60	Snow Survey	NWIS/NCEP, Cornell U., Bi-weekly, Daily		Nov - April	130	330			Water	Conventional nutrients, sediment and macroinvertebrates	Cornell U., NWIS Mid-At River Forest Cr., Site elevations by lat & long. Additional contact, Corps of Engineers/NCEP Reservoir/Hydrology	Daily map showing water equivalent is displayed on web page for NWIS mid-Atlantic river forecast center. Site elevations by lat & long. Additional contact, Corps of Engineers/NCEP Reservoir/Hydrology				
61	Riverkeeper Citizens Water Quality Monitoring Program	Volunteers for Riverkeeper	2x/mo	Jan-Dec	130	174	1991	Present	Water	Conventional nutrients, sediment and macroinvertebrates	Faith Zarche (215) 369-1188	Volunteer network monitors 80 sites in the Delaware River and tributaries.				
62	Christians Bird Count	National Audubon Society	Annual	Dec-Jan	0	90	1900	Present	Census	Relative Abundance	Vince Ellis (609) 961-0700	Bird recorded over a three week period Dec - Jan				
63	Delaware Observation Well Network	DNREC	Daily	Jan-Dec	30	60	1950	Present	Water Level			5 observation wells monitored daily.				
64	Benthic Influenza	Normandeau Assoc.			100	133	1981	Present	Biotic Census	Abundance	George Pelegre (610) 948-1700	George Pelegre (610) 948-1700	Computer file Quattro Pro, Excel, Access	Spreadsheet on present disk		
65	Macro Invertebrate Survey	DNREC			0	60	1974	Present	Biotic Census	Species richness and diversity	Division of Water Resources DE (302) 739-4593	Ginger North (302) 239-20-30 sites monitored at 3 times per year.				
67	Macro Invertebrate Survey	Del. Nat. Society	3x/yr		0	60	1986	Present	Biotic Census	abundance	2334 ext. 112	Dave McCaigde (202) 739-4771	Dave McCaigde (202) 739-4771	Computer file, Lotus spreadsheets	present	
68	Ambient Water Quality Survey	DNREC	Annual - Biannual		7	48	1985	Present	Water	Conventional nutrients, metals	Tom Barn (609) 748-4610	Constitutionalist striped bass tagging program administered by USFWS	Hard Copy	Stretel	Monthly	
69	Striped Bass Tagging Program	NUDEP	2-3/wk	Feb/Mar/Apr	30	130	1989	Present	Tagging Study	Fishing Mortality Estimate - Age/Ln Key	2020	Age of contribution to total population analysis.	computer file	?	?	
70	PA Ground Water Network (GWN)	PADEP	Bi-annual	Jan-Dec			1986	Present	Water	Conventional Nutrients, Metals	Shane Reese (717) 772-2345 ambient and 345 fixed station network monitoring points.					
71	Chester County Observation Well Network	USGS	12x/yr	Jan-Dec			1973	Present	Water levels	Ground water levels	Kirk White (610) 647-9008	Wells are densely distributed throughout Chester County, PA. Data stored in USGS GMS Data Base and used for rough forecasting and monitoring.				
72	Shellfish Program	DNREC	6x/yr	Apr-Nov	0	70	1970	Present	Water	Total Coliforms	Jack Pringle (302) 739-4590	Neck-shore and 30 mid-channel stations	Computer file, Lotus spreadsheets	disk, hard drive	present	
73	Small Mouth Bass Survey	DNREC	3-4x/yrno	May/Sept	72	1987	Present	Census	Length, weight, age, stock density	Mike Stanghell (302) 739-4782	Electroshocking in 15 sections of the Brandywine River (fishwater area)					
74	So. New Castle Co. Groundwater Monitoring Network	DGS	WRANCC	4x/yr	0	0	1984	Present	Groundwater Quality	Nutrients, Metals, TDS, Chlorides, Redox, Electric and pesticides	Stephanie Baxter (302) 831-6258	Groundwater Monitoring Network of 60+ wells and confined aquifer wells in Coastal Plain of Southern New Castle Co., DE. Purpose of program is to monitor the quality of groundwater which is sole source of drinking water.				
75	Christina River Basin Stormwater Monitoring Program	USGS	DNREC	6x/yr	Monthly	0	0	1987	Present	Stormwater Quality	Full list of EPA pollutants	Lisa Senior (610) 739-4590 ext. 209,	Characterize quality of stormwater runoff for representative land uses at 11 sites for later use in a TMDL model of the Christina Basin in DE, PA and MD			
76	WRANCC Recharge Monitoring Program (WRANCC)		4x/yr	Apr/Sept	0	0	1989	Present	Groundwater Quality	Levels, TDS, DOC, Nitrate, NH4 Conductivity, Redox, phosphate and chlorides	Gerald Kaufman (302) 831-4329	Monitoring program groundwater recharge benefits required by New Castle Co. Water Resource Protection Area Program				
77	Christina Basin Water Quality Management Strategy	WRANCC	n/a	n/a	0	0	1995	Present	GIS Mapping/Data	Geology, soils, utilities, discharge, land use, zoning, floodplain, wetlands, watersheds, aquifers, Su, perfrund sites	Gerald Kaufman 302-831-4925	15-map GIS Series prepared for Christina Basin Water Quality Management Strategy in DE, PA, and MD.				
78	New Castle Co. Water Supply/Demand	WRANCC	monthly/annually	n/a			1983	Present	Water use	Water supply/Demand Data	Gerald Kaufman 302-831-4925	Regional water supply and demand data for New Castle County, DE				
79	New Castle Co. Stream Flow Survey	DGS	WRANCC	daily	n/a		1980	Present	Stream flow, Reservoir storage	Flow, Water levels	Gerald Kaufman 302-831-4925	Daily stream flow measurements & 4 water supply tanks along the Brandywine Creek, Red Clay Creek, and White Clay Creek in New Castle County, DE				
80	UD Delaware GIS Mapping	WRANCC	daily	n/a			1975	Present	GIS Data	Roads, streams, land use, soils, etc.	Vern Swatos 302-831-4932	WRANCC operates an ARC/INFO GIS for water supply and water quality planning and management purposes in New Castle County, DE.				
87	Horseshoe Crab spawning census	UMAR Labs, Inc.	Annual	May-June	0	1980	Present	Counts	Ground counts samples at marsh N and DE Beach/Sw. L mud flats		Baywide sampling locations, conducted at full moon in May and June.					
88	Lower River Monitoring Program	DRBC	Bi-weekly	May-Sept.	134	210	1999	Present	Water	Conventional, Nutrients, Bacteria	Gerald Smith (609) 983-9500 ext. 2324		Excel	STORE		
89	Lower River Monitoring Program	DRBC	Annual	Aug-Sept	330	210	2001	Present	Benthic Macroinvertebrates, RSP/Habitat, particle size, depth and flow velocity	Gerald Smith (609) 983-9500 ext. 2324		EDAS, STORE	Excel			
90	River Tracker Network	Delaware Riverkeeper Network	Monthly	Jan-December	0		1991	Present	Water	Nitrate, Nitrogen, Orthophosphate, pH, dissolved oxygen, water temperature, air temp	Erik Zarche (610) 4650-6005 or (215) 369-1188	Developed as a first line of defense to detect trends over time. Data collected by trained volunteer monitors adhering to QA/QC standards. Sampling stations located throughout the Delaware River and its major tributaries.				
91	Adopt-A-Buffer Initiative	Delaware Riverkeeper Network	Twice a year	June and August	0		2002	Present	Habitat, stream restoration projects riparian buffers	quality of stream buffers (all project(s)) cross sections, macroinvertebrates, benthic Metrics, RSP/Habitat, particle size, selected projects	Faith Zarche (610) 4650-6005 or (215) 369-1188	Developed to alert project partners if projects need follow-up maintenance to junction				
92	Bug Watchers	Delaware Riverkeeper Network	Annual	March-April	0		2001	Present	Benthic Macroinvertebrates, benthic metrics, consolidation, dominant substrate types surrounding a house	Gerald Smith (609) 983-9500 ext. 2324	Trained volunteer monitors and DR staff make 30+ rehabilitated projects in the Waterfront (mostly New Jersey and Pennsylvania). DRN recruiting new volunteers to adopt other restoration projects.					
93	Pollution Monitoring Studies	Delaware Riverkeeper Network	Dependent on Project Needs		0		2003	Present	Benthic macroinvertebrates, water dissolved oxygen, habitat	Faith Zarche (610) 4650-6005 or (215) 369-1188	Project-based monitoring, parameters dependent on monitoring study design for suspected pollution problem. High level of rigor.					

12-2 List of Benthic Infauna Collected in the Delaware Estuary from the National Coastal Assessment Program 2000 Survey

CLASS	ORDER	FAMILY	GENUS	SPECIES	LATIN NAME
Polychaeta	Phyllodocida	Nephytidae	Aglaophamus	circinata	Aglaophamus circinata
Polychaeta	Terebellida	Ampharetidae	Ampharete	acutifrons	Ampharete acutifrons
Polychaeta	Terebellida	Ampharetidae			Ampharetidae
Polychaeta	Terebellida	Ampharetidae	Amphicteis	gunnery	Amphicteis gunnery
Polychaeta	Phyllodocida	Pilargidae	Ancistrosyllis	groenlandica	Ancistrosyllis groenlandica
Polychaeta	Phyllodocida	Pilargidae	Ancistrosyllis	hartmanae	Ancistrosyllis hartmanae
Polychaeta	Spionida	Cirratulidae	Aphelochaeta		Aphelochaeta spp.
Polychaeta	Spionida	Apistobranchidae	Apistobranchus	tullbergi	Apistobranchus tullbergi
Polychaeta	Spionida	Spionidae	Apopronospio	pygmaea	Apopronospio pygmaea
Polychaeta	Eunicida	Oenonidae	Arabella	iricolor	Arabella iricolor
Polychaeta	Eunicida	Oenonidae	Arabella	mutans	Arabella mutans
Polychaeta	Orbiniida	Paraonidae	Aricidea	catherinae	Aricidea catherinae
Polychaeta	Orbiniida	Paraonidae	Aricidea	cerrutii	Aricidea cerrutii
Polychaeta	Orbiniida	Paraonidae	Aricidea	quadrilobata	Aricidea quadrilobata
Polychaeta	Orbiniida	Paraonidae	Aricidea		Aricidea spp.
Polychaeta	Orbiniida	Paraonidae	Aricidea	suecica	Aricidea suecica
Polychaeta	Orbiniida	Paraonidae	Aricidea	wassi	Aricidea wassi
Polychaeta	Terebellida	Ampharetidae	Asabellides	oculata	Asabellides oculata
Polychaeta	Phyllodocida	Syllidae	Autolytus		Autolytus spp.
Polychaeta	Capitellida	Maldanidae	Axiothella	mucosa	Axiothella mucosa
Polychaeta	Phyllodocida	Syllidae	Brania	wellfleetensis	Brania wellfleetensis
Polychaeta	Phyllodocida	Pilargidae	Cabira	incerta	Cabira incerta
Polychaeta	Capitellida	Capitellidae	Capitella	capitata	Capitella capitata
Polychaeta	Capitellida	Capitellidae	Capitella	jonesi	Capitella jonesi
Polychaeta	Capitellida	Capitellidae			Capitellidae
Polychaeta	Spionida	Spionidae	Carazziella	hobsonae	Carazziella hobsonae
Polychaeta	Spionida	Cirratulidae	Cauilleriella	sp. J	Cauilleriella sp. J
Polychaeta	Spionida	Cirratulidae	Chaetozone	setosa	Chaetozone setosa
Polychaeta	Sabellida	Sabellidae	Chone		Chone spp.
Polychaeta	Spionida	Cirratulidae			Cirratulidae
Polychaeta	Spionida	Cirratulidae	Cirriformia	grandis	Cirriformia grandis
Polychaeta	Orbiniida	Paraonidae	Cirrophorus	armatus	Cirrophorus armatus
Polychaeta	Orbiniida	Paraonidae	Cirrophorus	brevicirratus	Cirrophorus brevicirratus
Polychaeta	Orbiniida	Paraonidae	Cirrophorus	lyra	Cirrophorus lyra
Polychaeta	Orbiniida	Paraonidae	Cirrophorus		Cirrophorus spp.
Polychaeta	Capitellida	Maldanidae	Clymenella	torquata	Clymenella torquata
Polychaeta	Cossurida	Cossuridae	Cossura	soyeri	Cossura soyeri
Polychaeta	Cossurida	Cossuridae	Cossurella		Cossurella spp.
Polychaeta	Cossurida	Cossuridae			Cossuridae
Polychaeta	Sabellida	Sabellidae	Demonax	microphthalmus	Demonax microphthalmus
Polychaeta	Sabellida	Sabellidae	Demonax		Demonax spp.
Polychaeta	Eunicida	Onuphidae	Diopatra	cuprea	Diopatra cuprea
Polychaeta	Flabelligerida	Flabelligeridae	Diplocirrus	hirsutus	Diplocirrus hirsutus
Polychaeta	Spionida	Spionidae	Dipolydora	caulleryi	Dipolydora caulleryi
Polychaeta	Spionida	Spionidae	Dipolydora	quadrilobata	Dipolydora quadrilobata
Polychaeta	Spionida	Spionidae	Dipolydora	socialis	Dipolydora socialis
Polychaeta	Spionida	Spionidae	Dispio	uncinata	Dispio uncinata

Polychaeta	Eunicida	Lumbrineridae			Dorvilleidae
Polychaeta	Eunicida	Oenonidae	Drilonereis	longa	Drilonereis longa
Oligochaeta	Tubificida	Enchytraeidae			Enchytraeidae
Polychaeta	Phyllodocida	Sphaerodoridae	Ephesiella	minuta	Ephesiella minuta
Polychaeta	Phyllodocida	Phyllodocidae	Eteone	longa	Eteone longa
Polychaeta	Sabellida	Sabellidae	Euchone	incolor	Euchone incolor
Polychaeta	Phyllodocida	Phyllodocidae	Eumida	sanguinea	Eumida sanguinea
Polychaeta	Terebellida	Terebellidae	Eupolymnia	nebulosa	Eupolymnia nebulosa
Polychaeta	Terebellida	Terebellidae	Eupolymnia		Eupolymnia spp.
Polychaeta	Phyllodocida	Syllidae	Exogone	dispar	Exogone dispar
Polychaeta	Phyllodocida	Syllidae	Exogone	hebes	Exogone hebes
Polychaeta	Phyllodocida	Syllidae	Exogone	longicirris	Exogone longicirris
Polychaeta	Phyllodocida	Syllidae	Exogone	rolani	Exogone rolani
Polychaeta	Phyllodocida	Syllidae	Exogone		Exogone spp.
Polychaeta	Phyllodocida	Syllidae	Exogone	verugera	Exogone verugera
Polychaeta	Phyllodocida	Sigalionidae	Fimbriosthenelais	minor	Fimbriosthenelais minor
Polychaeta	Oweniida	Oweniidae	Galathowenia	oculata	Galathowenia oculata
Polychaeta	Phyllodocida	Polynoidae	Gattyana	cirrosa	Gattyana cirrosa
Polychaeta	Phyllodocida	Glyceridae	Glycera	americana	Glycera americana
Polychaeta	Phyllodocida	Glyceridae	Glycera	capitata	Glycera capitata
Polychaeta	Phyllodocida	Glyceridae	Glycera	dibranchiata	Glycera dibranchiata
Polychaeta	Phyllodocida	Glyceridae	Glycera		Glycera spp.
Polychaeta	Phyllodocida	Glyceridae			Glyceridae
Polychaeta	Phyllodocida	Goniadidae	Glycinde	solitaria	Glycinde solitaria
Polychaeta	Phyllodocida	Goniadidae	Goniada	maculata	Goniada maculata
Polychaeta	Phyllodocida	Goniadidae	Goniadella	gracilis	Goniadella gracilis
Polychaeta	Phyllodocida	Goniadidae			Goniadidae
Polychaeta	Phyllodocida	Syllidae	Grubeosyllis	clavata	Grubeosyllis clavata
Polychaeta	Phyllodocida	Polynoidae	Harmothoe	extenuata	Harmothoe extenuata
Polychaeta	Phyllodocida	Polynoidae	Harmothoe	imbricata	Harmothoe imbricata
Polychaeta	Phyllodocida	Polynoidae	Harmothoe		Harmothoe spp.
Polychaeta	Phyllodocida	Hesionidae			Hesionidae
Polychaeta	Capitellida	Capitellidae	Heteromastus	filiformis	Heteromastus filiformis
Polychaeta	Capitellida	Capitellidae	Heteromastus		Heteromastus spp.
Polychaeta	Sabellida	Serpulidae	Hydroides	dianthus	Hydroides dianthus
Polychaeta	Sabellida	Serpulidae	Hydroides		Hydroides spp.
Polychaeta	Terebellida	Ampharetidae	Hypaniola		Hypaniola spp.
Polychaeta	Phyllodocida	Phyllodocidae	Hypereteone	fauchaldi	Hypereteone fauchaldi
Polychaeta	Phyllodocida	Phyllodocidae	Hypereteone	heteropoda	Hypereteone heteropoda
Polychaeta	Phyllodocida	Nereidae	Laeonereis	culveri	Laeonereis culveri
Polychaeta	Orbiniida	Orbiniidae	Leitoscoloplos	fragilis	Leitoscoloplos fragilis
Polychaeta	Orbiniida	Orbiniidae	Leitoscoloplos	robustus	Leitoscoloplos robustus
Polychaeta	Orbiniida	Orbiniidae	Leitoscoloplos		Leitoscoloplos spp.
Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	squamatus	Lepidonotus squamatus
Polychaeta	Phyllodocida	Polynoidae	Lepidonotus	sublevis	Lepidonotus sublevis
Polychaeta	Orbiniida	Paraonidae	Levinsenia	gracilis	Levinsenia gracilis
Oligochaeta	Tubificida	Tubificidae	Limnodrilus	hoffmeisteri	Limnodrilus hoffmeisteri
Polychaeta	Terebellida	Terebellidae	Loimia	medusa	Loimia medusa
Polychaeta	Terebellida	Terebellidae	Loimia	sp. A	Loimia sp. A
Polychaeta	Eunicida	Lumbrineridae			Lumbrineridae
Polychaeta	Eunicida	Lumbrineridae	Lumbrinerides	acuta	Lumbrinerides acuta

Polychaeta	Spionida	Magelonidae	Magelona	papillicornis	Magelona papillicornis
Polychaeta	Spionida	Magelonidae	Magelona	rosea	Magelona rosea
Polychaeta	Spionida	Magelonidae	Magelona		Magelona spp.
Polychaeta	Capitellida	Maldanidae			Maldanidae
Polychaeta	Sabellida	Sabellidae	Manayunkia	speciosa	Manayunkia speciosa
Polychaeta	Spionida	Spionidae	Marenzellaria	jonesi	Marenzellaria jonesi
Polychaeta	Spionida	Spionidae	Marenzellaria	viridis	Marenzellaria viridis
Polychaeta	Capitellida	Capitellidae	Mediomastus	ambiseta	Mediomastus ambiseta
Polychaeta	Capitellida	Capitellidae	Mediomastus	californiensis	Mediomastus californiensis
Polychaeta	Capitellida	Capitellidae	Mediomastus		Mediomastus spp.
Polychaeta	Sabellida	Sabellidae	Megalomma		Megalomma spp.
Polychaeta	Terebellida	Ampharetidae	Melinna	cristata	Melinna cristata
Polychaeta	Terebellida	Ampharetidae	Melinna	maculata	Melinna maculata
Polychaeta	Phyllodocida	Hesionidae	Microphthalmus	aberrans	Microphthalmus aberrans
Polychaeta	Phyllodocida	Hesionidae	Microphthalmus	hartmanae	Microphthalmus hartmanae
Polychaeta	Phyllodocida	Hesionidae	Microphthalmus	sczelkowii	Microphthalmus sczelkowii
Polychaeta	Phyllodocida	Hesionidae	Microphthalmus		Microphthalmus spp.
Polychaeta	Spionida	Cirratulidae	Monticellina	dorsobranchialis	Monticellina dorsobranchialis
Polychaeta	Eunicida	Eunicidae	Nematonereis	hebes	Nematonereis hebes
Polychaeta	Terebellida	Terebellidae	Neoamphitrite	johnstoni	Neoamphitrite johnstoni
Polychaeta	Terebellida	Terebellidae	Neoamphitrite	ornata	Neoamphitrite ornata
Polychaeta	Phyllodocida	Nephtyidae			Nephtyidae
Polychaeta	Phyllodocida	Nephtyidae	Nephtys	bucera	Nephtys bucura
Polychaeta	Phyllodocida	Nephtyidae	Nephtys	caeca	Nephtys caeca
Polychaeta	Phyllodocida	Nephtyidae	Nephtys	incisa	Nephtys incisa
Polychaeta	Phyllodocida	Nephtyidae	Nephtys	picta	Nephtys picta
Polychaeta	Phyllodocida	Nephtyidae	Nephtys		Nephtys spp.
Polychaeta	Phyllodocida	Nephtyidae	Nephtys	squamosa	Nephtys squamosa
Polychaeta	Phyllodocida	Nereidae			Nereididae
Polychaeta	Phyllodocida	Nereidae			Nereididae spp.
Polychaeta	Phyllodocida	Nereidae	Nereis	acuminata	Nereis acuminata
Polychaeta	Phyllodocida	Nereidae	Nereis	diversicolor	Nereis diversicolor
Polychaeta	Phyllodocida	Nereidae	Nereis	grayi	Nereis grayi
Polychaeta	Phyllodocida	Nereidae	Nereis	pelagica	Nereis pelagica
Polychaeta	Phyllodocida	Nereidae	Nereis	sp. F	Nereis sp. F
Polychaeta	Phyllodocida	Nereidae	Nereis		Nereis spp.
Polychaeta	Phyllodocida	Nereidae	Nereis	succinea	Nereis succinea
Polychaeta	Phyllodocida	Nereidae	Nereis	virens	Nereis virens
Polychaeta	Eunicida	Lumbrineridae	Ninoe	nigripes	Ninoe nigripes
Polychaeta	Capitellida	Capitellidae	Notomastus	hemipodus	Notomastus hemipodus
Polychaeta	Capitellida	Capitellidae	Notomastus	latericeus	Notomastus latericeus
Polychaeta	Capitellida	Capitellidae	Notomastus		Notomastus spp.
Polychaeta	Orbiniida	Questidae	Novaquesta	trifurcata	Novaquesta trifurcata
Polychaeta	Phyllodocida	Syllidae	Odontosyllis	fulgurans	Odontosyllis fulgurans
Polychaeta	Eunicida	Onuphidae			Onuphidae
Polychaeta	Eunicida	Onuphidae	Onuphis	eremita	Onuphis eremita
Polychaeta	Opheliida	Opheliidae	Ophelina	acuminata	Ophelina acuminata
Polychaeta	Eunicida	Dorvilleidae	Ophryotrocha		Ophryotrocha spp.
Polychaeta	Oweniida	Oweniidae	Owenia	fusiformis	Owenia fusiformis
Polychaeta	Oweniida	Oweniidae			Oweniidae
Polychaeta	Phyllodocida	Phyllodocidae	Paranaitis	speciosa	Paranaitis speciosa

Polychaeta	Orbiniida	Paraonidae	Paraonis	fulgens	Paraonis fulgens
Polychaeta	Orbiniida	Paraonidae	Paraonis		Paraonis spp.
Polychaeta	Phyllodocida	Syllidae	Parapionosyllis	longicirrata	Parapionosyllis longicirrata
Polychaeta	Spionida	Spionidae	Paraprionospio	pinnata	Paraprionospio pinnata
Polychaeta	Eunicida	Dorvilleidae	Parougia	caeca	Parougia caeca
Polychaeta	Terebellida	Pectinariidae	Pectinaria	gouldii	Pectinaria gouldii
Polychaeta	Terebellida	Pectinariidae	Pectinaria	granulata	Pectinaria granulata
Polychaeta	Terebellida	Pectinariidae			Pectinariidae
Polychaeta	Capitellida	Maldanidae	Petaloprotus	tenuis	Petaloprotus tenuis
Polychaeta	Eunicida	Dorvilleidae	Pettiboneia	duofurca	Pettiboneia duofurca
Polychaeta	Flabelligerida	Flabelligeridae	Pherusa	affinis	Pherusa affinis
Polychaeta	Flabelligerida	Flabelligeridae	Pherusa	plumosa	Pherusa plumosa
Polychaeta	Phyllodocida	Pholoidae	Pholoe	minuta	Pholoe minuta
Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	arenae	Phyllodoce arenae
Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	groenlandica	Phyllodoce groenlandica
Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce	maculata	Phyllodoce maculata
Polychaeta	Phyllodocida	Phyllodocidae	Phyllodoce		Phyllodoce spp.
Polychaeta	Phyllodocida	Phyllodocidae			Phyllodocidae
Polychaeta	Phyllodocida	Nereidae	Platynereis	dumerilli	Platynereis dumerilli
Polychaeta	Phyllodocida	Hesionidae	Podarke	obscura	Podarke obscura
Polychaeta	Phyllodocida	Hesionidae	Podarkeopsis	levifuscina	Podarkeopsis levifuscina
Polychaeta					Polychaeta
Polychaeta	Terebellida	Terebellidae	Polycirrus	sp. G	Polycirrus sp. G
Polychaeta	Terebellida	Terebellidae	Polycirrus		Polycirrus spp.
Polychaeta	Spionida	Spionidae	Polydora	cornuta	Polydora cornuta
Polychaeta	Archiannelida	Polygordiidae	Polygordius		Polygordius spp.
Polychaeta	Phyllodocida	Polynoidae			Polynoidae
Polychaeta	Sabellida	Sabellidae	Potamilla	neglecta	Potamilla neglecta
Polychaeta	Capitellida	Maldanidae	Praxillella	gracilis	Praxillella gracilis
Polychaeta	Spionida	Spionidae	Prionospio	heterobranchia	Prionospio heterobranchia
Polychaeta	Spionida	Spionidae	Prionospio	perkinsi	Prionospio perkinsi
Polychaeta	Spionida	Spionidae	Prionospio		Prionospio spp.
Polychaeta	Spionida	Spionidae	Prionospio	steenstrupi	Prionospio steenstrupi
Polychaeta	Spionida	Spionidae	Pseudopolydora	diopatra	Pseudopolydora diopatra
Polychaeta	Spionida	Spionidae	Pseudopolydora		Pseudopolydora spp.
Polychaeta	Sabellida	Sabellidae	Pseudopotamilla	sp. A	Pseudopotamilla sp. A
Polychaeta	Spionida	Spionidae	Pygospio	elegans	Pygospio elegans
Polychaeta	Capitellida	Maldanidae	Rhodine	loveni	Rhodine loveni
Polychaeta	Capitellida	Maldanidae	Sabaco	americanus	Sabaco americanus
Polychaeta	Terebellida	Sabellariidae	Sabellaria	vulgaris	Sabellaria vulgaris
Polychaeta	Sabellida	Sabellidae			Sabellidae
Polychaeta	Opheliida	Scalibregmatidae	Scalibregma	inflatum	Scalibregma inflatum
Polychaeta	Eunicida	Dorvilleidae	Schistomerings	rudolphi	Schistomerings rudolphi
Polychaeta	Spionida	Spionidae	Scolelepis		Scolelepis spp.
Polychaeta	Spionida	Spionidae	Scolelepis	squamata	Scolelepis squamata
Polychaeta	Spionida	Spionidae	Scolelepis	texana	Scolelepis texana
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	acicularum	Scoletoma acicularum
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	ernesti	Scoletoma ernesti
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	fragilis	Scoletoma fragilis
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	hebes	Scoletoma hebes
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	impatiens	Scoletoma impatiens

Polychaeta	Eunicida	Lumbrineridae	Scoletoma		Scoletoma spp.
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	tenuis	Scoletoma tenuis
Polychaeta	Eunicida	Lumbrineridae	Scoletoma	verrilli	Scoletoma verrilli
Polychaeta	Orbiniida	Orbiniidae	Scoloplos	armiger	Scoloplos armiger
Polychaeta	Orbiniida	Orbiniidae	Scoloplos	rubra	Scoloplos rubra
Polychaeta	Sabellida	Serpulidae			Serpulidae
Polychaeta	Phyllodocida	Sigalionidae	Sigalion	arenicola	Sigalion arenicola
Polychaeta	Phyllodocida	Pilargidae	Sigambra	tentaculata	Sigambra tentaculata
Polychaeta	Phyllodocida	Syllidae	Sphaerosyllis	perkinsi	Sphaerosyllis perkinsi
Polychaeta	Phyllodocida	Syllidae	Sphaerosyllis	taylori	Sphaerosyllis taylori
Polychaeta	Spionida	Spionidae	Spio	filicornis	Spio filicornis
Polychaeta	Spionida	Spionidae	Spio	goniocephala	Spio gonocephala
Polychaeta	Spionida	Spionidae	Spio	setosa	Spio setosa
Polychaeta	Spionida	Spionidae	Spio	sp. A	Spio sp. A
Polychaeta	Spionida	Spionidae	Spio		Spio spp.
Polychaeta	Spionida	Chaetopteridae	Spiochaetopterus	oculatus	Spiochaetopterus oculatus
Polychaeta	Spionida	Spionidae			Spionidae
Polychaeta	Spionida	Spionidae	Spiophanes	bombyx	Spiophanes bombyx
Polychaeta	Spionida	Spionidae	Spiophanes	wigleyi	Spiophanes wigleyi
Polychaeta	Sternaspida	Sternaspidae	Sternaspis	scutata	Sternaspis scutata
Polychaeta	Phyllodocida	Sigalionidae	Sthenelais	boa	Sthenelais boa
Polychaeta	Phyllodocida	Sigalionidae	Sthenelais	limicola	Sthenelais limicola
Polychaeta	Spionida	Spionidae	Streblospio	benedicti	Streblospio benedicti
Polychaeta	Phyllodocida	Syllidae	Streptosyllis	arenae	Streptosyllis arenae
Polychaeta	Phyllodocida	Syllidae	Streptosyllis	varians	Streptosyllis varians
Polychaeta	Phyllodocida	Syllidae			Syllidae
Polychaeta	Phyllodocida	Syllidae			Syllidae spp.
Polychaeta	Phyllodocida	Syllidae	Syllides	longocirrata	Syllides longocirrata
Polychaeta	Phyllodocida	Syllidae	Syllides	setosa	Syllides setosa
Polychaeta	Phyllodocida	Syllidae	Syllis	cornuta	Syllis cornuta
Polychaeta	Phyllodocida	Syllidae	Syllis		Syllis spp.
Polychaeta	Terebellida	Terebellidae			Terebellidae
Polychaeta	Terebellida	Trichobranchidae	Terebellides	stroemi	Terebellides stroemi
Polychaeta	Spionida	Cirratulidae	Tharyx	acutus	Tharyx acutus
Polychaeta	Spionida	Cirratulidae	Tharyx	kirkegaardi	Tharyx kirkegaardi
Polychaeta	Opheliida	Opheliidae	Travisia	carnea	Travisia carnea
Oligochaeta	Tubificida	Tubificidae			Tubificidae
Malacostraca	Amphipoda	Haustoriidae	Acanthohaustorius	intermedius	Acanthohaustorius intermedius
Malacostraca	Amphipoda	Haustoriidae	Acanthohaustorius	millsi	Acanthohaustorius millsii
Malacostraca	Amphipoda	Aoridae	Acuminodeutopus	naglei	Acuminodeutopus naglei
Malacostraca	Amphipoda	Aeginellidae			Aeginellidae
Malacostraca	Amphipoda	Aeginellidae	Aeginina	longicornis	Aeginina longicornis
Malacostraca	Cumacea	Nannastacidae	Almyracuma	proximoculi	Almyracuma proximoculi
Malacostraca	Mysidacea	Mysidae	Americanysis	bigelowi	Americanysis bigelowi
Malacostraca	Amphipoda	Oedicerotidae	Americhelidium	americanum	Americhelidium americanum
Malacostraca	Amphipoda	Ampeliscidae	Ampelisca		Ampelisca
Malacostraca	Amphipoda	Ampeliscidae	Ampelisca		Ampelisca spp.
Malacostraca	Amphipoda	Ampeliscidae	Ampelisca	verrilli	Ampelisca verrilli
Malacostraca	Amphipoda	Ampeliscidae			Ampeliscidae
Malacostraca	Amphipoda				Amphipoda
Malacostraca	Amphipoda	Ampithoidae			Ampithoidae

Malacostraca	Isopoda	Sphaeromatidae	Ancinus	depressus	Ancinus depressus
Malacostraca	Amphipoda	Lysianassidae	Anonyx	liljeborgii	Anonyx liljeborgii
Malacostraca	Amphipoda	Aoridae			Aoridae
Malacostraca	Amphipoda	Corophiidae	Apocorophium	lacustre	Apocorophium lacustre
Malacostraca	Amphipoda	Argissidae	Argissa	hamatipes	Argissa hamatipes
Arachnida	Acari	Arrenuridae	Arrenurus		Arrenurus spp.
Malacostraca	Amphipoda	Bateidae	Batea	catharinensis	Batea catharinensis
Malacostraca	Amphipoda	Bateidae	Batea		Batea spp.
Malacostraca	Amphipoda	Haustoriidae	Bathyporeia	quoddyensis	Bathyporeia quoddyensis
Malacostraca	Amphipoda	Ampeliscidae	Byblis		Byblis spp.
Malacostraca	Decapoda	Callianassidae	Callianassa	setimanus	Callianassa setimanus
Malacostraca	Decapoda	Callianassidae	Callianassa		Callianassa spp.
Malacostraca	Cumacea	Nannastacidae	Campylaspis	affinis	Campylaspis affinis
Malacostraca	Decapoda	Cancridae	Cancer	borealis	Cancer borealis
Malacostraca	Decapoda	Cancridae	Cancer	irroratus	Cancer irroratus
Malacostraca	Amphipoda	Caprellidae	Caprella	penantis	Caprella penantis
Malacostraca	Amphipoda	Caprellidae	Caprella		Caprella spp.
Malacostraca	Amphipoda	Melitidae	Casco	bigelowi	Casco bigelowi
Malacostraca	Amphipoda	Ischyroceridae	Cerapus	tubularis	Cerapus tubularis
Insecta	Diptera	Ceratopogonidae			Ceratopogonidae
Malacostraca	Isopoda	Idoteidae	Chiridotea	caeca	Chiridotea caeca
Malacostraca	Isopoda	Idoteidae	Chiridotea	tuftsi	Chiridotea tuftsi
Insecta	Diptera	Chironomidae			Chironomidae
Insecta	Diptera	Chironomidae	Chironomus		Chironomus spp.
Malacostraca	Amphipoda	Corophiidae			Corophiidae
Malacostraca	Amphipoda	Corophiidae	Corophium		Corophium spp.
Malacostraca	Amphipoda	Corophiidae	Corophium	volutator	Corophium volutator
Malacostraca	Decapoda	Crangonidae	Crangon	septemspinosa	Crangon septemspinosa
Malacostraca	Decapoda	Crangonidae			Crangonidae
Malacostraca	Amphipoda	Corophiidae	Crassicorophium	crassicorn	Crassicorophium crassicorn
Insecta	Diptera	Chironomidae	Cricotopus		Cricotopus spp.
Insecta	Diptera	Chironomidae	Cryptochironomus		Cryptochironomus spp.
Malacostraca	Cumacea				Cumacea
Malacostraca	Isopoda	Anthuridae	Cyathura	polita	Cyathura polita
Malacostraca	Cumacea	Bodotriidae	Cyclaspis	pustulata	Cyclaspis pustulata
Malacostraca	Cumacea	Bodotriidae	Cyclaspis	varians	Cyclaspis varians
Ostracoda	Myodocopina	Cylindroleberididae			Cylindroleberididae
Malacostraca	Amphipoda	Ampithoidae	Cymadusa	compta	Cymadusa compta
Malacostraca	Decapoda				Decapoda
Malacostraca	Amphipoda	Oedicerotidae	Deflexilodes	intermedius	Deflexilodes intermedius
Malacostraca	Amphipoda	Dexaminidae	Dexamine	thea	Dexamine thea
Malacostraca	Cumacea	Diastylidae			Diastylidae
Malacostraca	Cumacea	Diastylidae	Diastylis	abbreviata	Diastylis abbreviata
Malacostraca	Cumacea	Diastylidae	Diastylis	polita	Diastylis polita
Malacostraca	Cumacea	Diastylidae	Diastylis	sculpta	Diastylis sculpta
Malacostraca	Cumacea	Diastylidae	Diastylis	sp. J	Diastylis sp. J
Malacostraca	Cumacea	Diastylidae	Diastylis		Diastylis spp.
Malacostraca	Decapoda	Pinnotheridae	Dissodactylus	mellitae	Dissodactylus mellitae
Malacostraca	Amphipoda	Podoceridae	Dulichia	orrecta	Dulichia porrecta
Malacostraca	Amphipoda	Melitidae	Dulichiella	appendiculata	Dulichiella appendiculata
Malacostraca	Amphipoda	Melitidae	Dulichiella		Dulichiella spp.

Malacostraca	Isopoda	Idoteidae	Edotia	triloba	Edotia triloba
Malacostraca	Amphipoda	Melitidae	Elasmopus	levis	Elasmopus levis
Malacostraca	Amphipoda	Melitidae	Elasmopus		Elasmopus spp.
Malacostraca	Amphipoda	Phoxocephalidae	Eobrolgus	spinosa	Eobrolgus spinosus
Malacostraca	Isopoda	Idoteidae	Erichsonella	attenuata	Erichsonella attenuata
Malacostraca	Isopoda	Idoteidae	Erichsonella	filiformis	Erichsonella filiformis
Malacostraca	Isopoda	Idoteidae	Erichsonella		Erichsonella spp.
Malacostraca	Amphipoda	Ischyroceridae	Erichthonius	brasiliensis	Erichthonius brasiliensis
Malacostraca	Amphipoda	Ischyroceridae	Erichthonius	rubricornis	Erichthonius rubricornis
Malacostraca	Amphipoda	Ischyroceridae	Erichthonius		Erichthonius spp.
Malacostraca	Cumacea	Leuconidae	Eudorella	pusilla	Eudorella pusilla
Malacostraca	Cumacea	Leuconidae	Eudorella		Eudorella spp.
Ostracoda	Myodocopina	Sarsiellidae	Eusarsiella	ozotothrix	Eusarsiella ozotothrix
Ostracoda	Myodocopina	Sarsiellidae	Eusarsiella	spinosa	Eusarsiella spinosa
Ostracoda	Myodocopina	Sarsiellidae	Eusarsiella		Eusarsiella spp.
Ostracoda	Myodocopina	Sarsiellidae	Eusarsiella	texana	Eusarsiella texana
Ostracoda	Myodocopina	Sarsiellidae	Eusarsiella	zostericola	Eusarsiella zostericola
Malacostraca	Amphipoda	Gammaridae			Gammaridae
Malacostraca	Amphipoda	Gammaridae	Gammarus	annulatus	Gammarus annulatus
Malacostraca	Amphipoda	Gammaridae	Gammarus	mucronatus	Gammarus mucronatus
Malacostraca	Amphipoda	Gammaridae	Gammarus	palustris	Gammarus palustris
Malacostraca	Amphipoda	Gammaridae	Gammarus		Gammarus spp.
Malacostraca	Amphipoda	Aoridae	Globosolembos	smithi	Globosolembos smithi
Arachnida	Acari	Halacaridae			Halacaridae
Ostracoda	Podocopida	Cytherideidae	Haplocytheridea	setipunctata	Haplocytheridea setipunctata
Ostracoda	Podocopida	Cytherideidae	Haplocytheridea	sp. B	Haplocytheridea sp. B
Malacostraca	Tanaidacea	Paratanaidae	Hargeria	rapax	Hargeria rapax
Insecta	Diptera	Chironomidae	Harnischia		Harnischia spp.
Malacostraca	Amphipoda	Phoxocephalidae	Harpinia	propinqua	Harpinia propinqua
Malacostraca	Amphipoda	Oedicerotidae	Hartmanodes		Hartmanodes spp.
Malacostraca	Amphipoda	Haustoriidae			Haustoriidae
Malacostraca	Mysidacea	Mysidae	Heteromysis	formosa	Heteromysis formosa
Cephalocarida		Hutchinsoniellidae	Hutchinsonella	macrocantha	Hutchinsonella macrocantha
Arachnida	Acari	Eremaeidae	Hydrozetes		Hydrozetes spp.
Malacostraca	Isopoda	Idoteidae	Idotea	balthica	Idotea balthica
Malacostraca	Isopoda	Idoteidae	Idotea	metallica	Idotea metallica
Malacostraca	Isopoda	Idoteidae	Idotea	phosphorea	Idotea phosphorea
Branchiopoda	Anomopoda	Macrothricidae	Ilyocryptus		Ilyocryptus spp.
Malacostraca	Amphipoda	Isaeidae			Isaeidae
Malacostraca	Amphipoda	Ischyroceridae			Ischyroceridae
Malacostraca	Amphipoda	Ischyroceridae	Ischyrocerus	anguipes	Ischyrocerus anguipes
Malacostraca	Amphipoda	Ischyroceridae	Jassa	falcata	Jassa falcata
Malacostraca	Cumacea	Lampropidae	Lamprops	quadriplicata	Lamprops quadriplicata
Malacostraca	Amphipoda	Aoridae	Lembos	websteri	Lembos websteri
Malacostraca	Amphipoda	Aoridae	Leptocheirus	pinguis	Leptocheirus pinguis
Malacostraca	Amphipoda	Aoridae	Leptocheirus	plumulosus	Leptocheirus plumulosus
Malacostraca	Amphipoda	Aoridae	Leptocheirus		Leptocheirus spp.
Malacostraca	Tanaidacea	Leptochelidae	Leptochelia	savignyi	Leptochelia savignyi
Malacostraca	Tanaidacea	Paratanaidae	Leptochelia		Leptochelia spp.
Malacostraca	Cumacea	Diastylidae	Leptostylis	longimana	Leptostylis longimana
Malacostraca	Cumacea	Leuconidae	Leucon	americanus	Leucon americanus

Malacostraca	Decapoda	Majidae	Libinia	dubia	Libinia dubia
Arachnida	Acari	Limnesiidae	Limnesia		Limnesia spp.
Merostomata	Xiphosura	Limulidae	Limulus	polyphemus	Limulus polyphemus
Malacostraca	Amphipoda	Liljeborgiidae	Listriella	barnardi	Listriella barnardi
Malacostraca	Amphipoda	Liljeborgiidae	Listriella		Listriella spp.
Malacostraca	Amphipoda	Lysianassidae			Lysianassidae
Malacostraca	Amphipoda	Lysianassidae	Lysianopsis	alba	Lysianopsis alba
Malacostraca	Decapoda	Majidae			Majidae
Malacostraca	Amphipoda	Protellidae	Mayerella	limicola	Mayerella limicola
Malacostraca	Amphipoda	Melitidae	Melita	nitida	Melita nitida
Malacostraca	Amphipoda	Melitidae			Melitidae
Malacostraca	Amphipoda	Stenothoidae	Metopella	angusta	Metopella angusta
Malacostraca	Amphipoda	Aoridae	Microdeutopus	anomalus	Microdeutopus anomalus
Malacostraca	Amphipoda	Aoridae	Microdeutopus	gryllopalpa	Microdeutopus gryllopalpa
Malacostraca	Amphipoda	Aoridae	Microdeutopus		Microdeutopus spp.
Malacostraca	Amphipoda	Isaeidae	Microtopotus	raneyi	Microtopotus raneyi
Malacostraca	Amphipoda	Isaeidae	Microtopotus	sp. E	Microtopotus sp. E
Arachnida	Acari	Mideopsidae	Mideopsis		Mideopsis spp.
Malacostraca	Amphipoda	Corophiidae	Monocorophium	acherusicum	Monocorophium acherusicum
Malacostraca	Amphipoda	Corophiidae	Monocorophium	insidiosum	Monocorophium insidiosum
Malacostraca	Amphipoda	Corophiidae	Monocorophium	tuberculatum	Monocorophium tuberculatum
Malacostraca	Amphipoda	Oedicerotidae	Monoculodes		Monoculodes spp.
Malacostraca	Isopoda	Munnidae	Munna	fabricii	Munna fabricii
Malacostraca	Mysidacea				Mysidacea
Malacostraca	Mysidacea	Mysidae			Mysidae
Malacostraca	Mysidacea	Mysidae	Neomysis	americana	Neomysis americana
Malacostraca	Decapoda	Xanthidae	Neopanope	sayi	Neopanope sayi
Arachnida	Acari	Unionicolidae	Neumania		Neumania spp.
Malacostraca	Amphipoda	Oedicerotidae			Oedicerotidae
Malacostraca	Decapoda	Ogyrididae	Ogyrides	alphaerostris	Ogyrides alphaerostris
Malacostraca	Amphipoda	Lysianassidae	Orchomenella	minuta	Orchomenella minuta
Ostracoda					Ostracoda
Ostracoda	Podocopida	Family P			Ostracodea Family P
Malacostraca	Decapoda	Portunidae	Ovalipes	ocellatus	Ovalipes ocellatus
Arachnida	Acari	Oxidae	Oxus		Oxus spp.
Malacostraca	Cumacea	Diastylidae	Oxyurostylis	smithi	Oxyurostylis smithi
Malacostraca	Decapoda	Paguridae			Paguridae
Malacostraca	Decapoda	Paguridae	Pagurus	longicarpus	Pagurus longicarpus
Malacostraca	Decapoda	Paguridae	Pagurus	politus	Pagurus politus
Malacostraca	Decapoda	Paguridae	Pagurus		Pagurus spp.
Malacostraca	Decapoda	Palaemonidae	Palaemonetes	vulgaris	Palaemonetes vulgaris
Malacostraca	Decapoda	Palaemonidae			Palaemonidae
Malacostraca	Decapoda	Xanthidae	Panopeus	herbstii	Panopeus herbstii
Malacostraca	Amphipoda	Aeginellidae	Paracaprella	tenuis	Paracaprella tenuis
Malacostraca	Amphipoda	Haustoriiidae	Parahaustorius	longimerus	Parahaustorius longimerus
Ostracoda	Myodocopina	Cylindroleberididae	Parasterope	pollex	Parasterope pollex
Ostracoda	Podocopida	Paradoxostomatidae	Pellucistoma		Pellucistoma spp.
Malacostraca	Decapoda	Penaeidae	Penaeus	aztecus	Penaeus aztecus
Malacostraca	Amphipoda	Isaeidae	Photis	macrocoxa	Photis macrocoxa
Malacostraca	Amphipoda	Isaeidae	Photis		Photis spp.
Malacostraca	Amphipoda	Phoxocephalidae			Phoxocephalidae

Malacostraca	Amphipoda	Phoxocephalidae	Phoxocephalus	holbolli	Phoxocephalus holbolli
Malacostraca	Decapoda	Pinnotheridae	Pinnixa	chaetopterana	Pinnixa chaetopterana
Malacostraca	Decapoda	Pinnotheridae	Pinnixa	sayana	Pinnixa sayana
Malacostraca	Decapoda	Pinnotheridae	Pinnixa		Pinnixa spp.
Malacostraca	Decapoda	Pinnotheridae	Pinnotheres	ostreum	Pinnotheres ostreum
Malacostraca	Decapoda	Pinnotheridae			Pinnotheridae
Malacostraca	Isopoda	Paramunnidae	Pleurogonium	spinosissimum	Pleurogonium spinosissimum
Malacostraca	Isopoda	Paramunnidae	Pleurogonium		Pleurogonium spp.
Ostracoda	Podocopida				Podocopida
Ostracoda	Podocopida	Family C			Podocopida Family C
Malacostraca	Isopoda	Cirolanidae	Politolana	politina	Politolana polita
Insecta	Diptera	Chironomidae	Polypedilum	illinoense	Polypedilum illinoense group
Insecta	Diptera	Chironomidae	Polypedilum	scalaenum	Polypedilum scalaenum group
Insecta	Diptera	Chironomidae	Polypedilum	simulans	Polypedilum simulans group
Insecta	Diptera	Chironomidae	Polypedilum		Polypedilum spp.
Malacostraca	Amphipoda	Pontogeneidae	Pontogeneia	inermis	Pontogeneia inermis
Malacostraca	Decapoda	Portunidae			Portunidae
Insecta	Diptera	Chironomidae	Procladius		Procladius spp.
Malacostraca	Amphipoda	Haustoriidae	Protohaustorius		Protohaustorius spp.
Malacostraca	Amphipoda	Haustoriidae	Protohaustorius	wigleyi	Protohaustorius wigleyi
Ostracoda	Podocopida	Brachycytheridae	Pterygocythereis	sp. A	Pterygocythereis sp. A
Malacostraca	Isopoda	Anthuridae	Ptilanthura	tenuis	Ptilanthura tenuis
Malacostraca	Amphipoda	Phoxocephalidae	Rhepoxyinius	hudsoni	Rhepoxyinius hudsoni
Malacostraca	Decapoda	Xanthidae	Rhithropanopeus	harrisi	Rhithropanopeus harrisi
Branchiopoda	Ctenopoda	Sididae	Sida	crystallina	Sida crystallina
Arachnida	Acari	Sperchontidae	Sperchon		Sperchon spp.
Malacostraca	Amphipoda	Pleustidae	Stenopleustes	gracilis	Stenopleustes gracilis
Malacostraca	Amphipoda	Pleustidae	Stenopleustes	inermis	Stenopleustes inermis
Insecta	Diptera	Chironomidae	Stictochironomus		Stictochironomus spp.
Malacostraca	Isopoda	Idoteidae	Synidotea	sp. F	Synidotea sp. F
Malacostraca	Tanaidacea	Nototanaidae	Tanaissus	lijeborgi	Tanaissus lijeborgi
Malacostraca	Tanaidacea	Nototanaidae	Tanaissus	psammophilus	Tanaissus psammophilus
Malacostraca	Tanaidacea	Nototanaidae	Tanaissus		Tanaissus spp.
Insecta	Diptera	Chironomidae	Tanytarsus		Tanytarsus spp.
Malacostraca	Amphipoda	Synopiidae	Tiron	spiniferus	Tiron spiniferus
Malacostraca	Amphipoda	Talitridae	Uhlorchestia	uhleri	Uhlorchestia uhleri
Malacostraca	Amphipoda	Aoridae	Unciola	irrorata	Unciola irrorata
Malacostraca	Amphipoda	Aoridae	Unciola	serrata	Unciola serrata
Malacostraca	Amphipoda	Aoridae	Unciola		Unciola spp.
Malacostraca	Decapoda	Upogebiidae	Upogebia	affinis	Upogebia affinis
Malacostraca	Decapoda	Xanthidae			Xanthidae
					Bryozoa
Asciidae					Asciidae
Leptocardia	Amphioxi	Branchiostomidae	Branchiostoma		Branchiostoma spp.
Asciidae	Pleurogona	Styelidae	Dendrodoa	carnea	Dendrodoa carnea
Asciidae	Pleurogona	Styelidae	Styela	clava	Styela clava
Anthozoa	Actiniaria				Actiniaria
Hydrozoa	Athecata	Clavidae	Clava	multicornis	Clava multicornis
Hydrozoa					Hydrozoa
Ophiuroidea	Ophiurida	Amphiuridae	Amphioplus	abditus	Amphioplus abditus
Ophiuroidea	Ophiurida	Amphiuridae	Amphipholis	squamata	Amphipholis squamata

Ophiuroidae	Ophiurida	Amphiuridae			Amphiuridae
Astroidea	Forcipulatida	Asteriidae	Asterias	forbesi	Asterias forbesi
Astroidea					Astroidea
Echinoidea	Clypeasteroida	Echinarchnidae	Echinarchnus	parma	Echinarchnus parma
					Echinodermata
Echinoidea					Echinoidea
Holothuroidea					Holothuroidea
Holothuroidea	Apodida	Synaptidae	Leptosynapta	tenuis	Leptosynapta tenuis
Ophiuroidae	Ophiurida	Ophiuridae	Ophiura	sarsi	Ophiura sarsi
Ophiuroidae					Ophiuroidae
Holothuroidea	Dendrochirotida	Sclerodactylidae	Sclerodactyla	briareus	Sclerodactyla briareus
Bivalvia	Veneroida	Semelidae	Abra	lioica	Abra lioica
Gastropoda	Cephalaspidea	Scaphandridae	Acteocina	canaliculata	Acteocina canaliculata
Gastropoda	Mesogastropoda	Rissoidae	Alvania	pelagica	Alvania pelagica
Gastropoda	Neogastropoda	Buccinidae	Amphissa	haliaeeti	Amphissa haliaeeti
Bivalvia	Mytiloidea	Mytilidae	Amygdalum	papyria	Amygdalum papyria
Gastropoda	Neogastropoda	Columbellidae	Anachis	lafresnayi	Anachis lafresnayi
Bivalvia	Arcoida	Arcidae	Anadara	transversa	Anadara transversa
Bivalvia	Ostreoida	Anomiidae	Anomia	simplex	Anomia simplex
Aplacophora					Aplacophora
Bivalvia	Ostreoida	Pectinidae	Argopecten	irradians concentricus	Argopecten irradians concentricus
Bivalvia	Veneroida	Astartidae	Astarte	borealis	Astarte borealis
Bivalvia	Veneroida	Astartidae	Astarte	castanea	Astarte castanea
Bivalvia	Veneroida	Astartidae	Astarte		Astarte spp.
Bivalvia	Veneroida	Astartidae	Astarte	undata	Astarte undata
Gastropoda	Mesogastropoda	Cerithiidae	Bittium	alternatum	Bittium alternatum
Bivalvia					Bivalvia
Gastropoda	Mesogastropoda	Caecidae	Caecum	pulchellum	Caecum pulchellum
Gastropoda	Mesogastropoda	Caecidae	Caecum		Caecum spp.
Gastropoda	Mesogastropoda	Calyptaeidae			Calyptaeidae
Bivalvia	Veneroida	Cardiidae	Cerastoderma	pinnulatum	Cerastoderma pinnulatum
Gastropoda	Mesogastropoda	Cerithiidae			Cerithiidae
Gastropoda	Mesogastropoda	Vitrinellidae	Circulus	multistriatus	Circulus multistriatus
Bivalvia	Veneroida	Corbiculidae	Corbicula	fluminea	Corbicula fluminea
Bivalvia	Myoida	Corbulidae	Corbula	contracta	Corbula contracta
Bivalvia	Veneroida	Crassatellidae	Crassinella	lunulata	Crassinella lunulata
Bivalvia	Ostreoida	Ostreidae	Crassostrea	virginica	Crassostrea virginica
Bivalvia	Mytiloidea	Mytilidae	Crenella	decussata	Crenella decussata
Gastropoda	Mesogastropoda	Calyptaeidae	Crepidula	convexa	Crepidula convexa
Gastropoda	Mesogastropoda	Calyptaeidae	Crepidula	fornicata	Crepidula fornicate
Gastropoda	Mesogastropoda	Calyptaeidae	Crepidula	plana	Crepidula plana
Gastropoda	Mesogastropoda	Calyptaeidae	Crepidula		Crepidula spp.
Bivalvia	Veneroida	Carditidae	Cyclocardia	borealis	Cyclocardia borealis
Gastropoda	Cephalaspidea	Scaphandridae	Cylichna	gouldi	Cylichna gouldi
Gastropoda	Cephalaspidea	Scaphandridae	Cylichnella	oryza	Cylichnella oryza
Gastropoda	Nudibranchia	Corambidae	Doridella	obscura	Doridella obscura
Bivalvia	Veneroida	Solenidae	Ensis	directus	Ensis directus
Bivalvia	Veneroida	Solenidae	Ensis		Ensis spp.
Gastropoda	Neogastropoda	Muricidae	Eupleura	caudata	Eupleura caudata
Gastropoda	Mesogastropoda	Naticidae	Euspira	heros	Euspira heros
Gastropoda					Gastropoda

Bivalvia	Veneroida	Veneridae	Gemma	gemma	Gemma gemma
Bivalvia	Mytiloidea	Mytilidae	Geukensia	demissa	Geukensia demissa
Gastropoda	Cephalaspidea	Hamineidae	Haminoea	solitaria	Haminoea solitaria
Bivalvia	Myoida	Hiatellidae	Hiatella	arctica	Hiatella arctica
Gastropoda	Mesogastropoda	Hydrobiidae	Hydrobia	totteni	Hydrobia totteni
Gastropoda	Mesogastropoda	Hydrobiidae			Hydrobiidae
Gastropoda	Neogastropoda	Nassariidae	Ilyanassa	obsoleta	Ilyanassa obsoleta
Gastropoda	Neogastropoda	Nassariidae	Ilyanassa	trivittata	Ilyanassa trivittata
Gastropoda	Neogastropoda	Turridae	Kurtziella	cerina	Kurtziella cerina
Gastropoda	Mesogastropoda	Littorinidae	Lacuna	vincta	Lacuna vincta
Bivalvia	Veneroida	Cardiidae	Laevicardium	mortoni	Laevicardium mortoni
Gastropoda	Mesogastropoda	Littorinidae	Littorina	irrorata	Littorina irrorata
Gastropoda	Mesogastropoda	Littorinidae	Littorina	littorea	Littorina littorea
Bivalvia	Veneroida	Lucinidae			Lucinidae
Bivalvia	Pholadomyoida	Lyonsiidae	Lyonsia	hyalina	Lyonsia hyalina
Bivalvia	Veneroida	Tellinidae	Macoma	balthica	Macoma balthica
Bivalvia	Veneroida	Tellinidae	Macoma		Macoma spp.
Bivalvia	Veneroida	Tellinidae	Macoma	tenta	Macoma tenta
Bivalvia	Veneroida	Mactridae			Mactridae
Bivalvia	Veneroida	Veneridae	Mercenaria	mercenaria	Mercenaria mercenaria
Gastropoda	Neogastropoda	Columbellidae	Mitrella	lunata	Mitrella lunata
Gastropoda	Neogastropoda	Columbellidae	Mitrella		Mitrella spp.
Bivalvia	Veneroida	Montacutidae			Montacutidae
Bivalvia	Veneroida	Mactridae	Mulinia	lateralis	Mulinia lateralis
Gastropoda	Neogastropoda	Muricidae			Muricidae
Bivalvia	Myoida	Myidae	Mya	arenaria	Mya arenaria
Bivalvia	Myoida	Myidae	Mya		Mya spp.
Bivalvia	Myoida	Myidae			Myidae
Bivalvia	Veneroida	Montacutidae	Mysella	planulata	Mysella planulata
Bivalvia	Mytiloidea	Mytilidae			Mytilidae
Bivalvia	Mytiloidea	Mytilidae	Mytilus	edulis	Mytilus edulis
Gastropoda	Neogastropoda	Nassariidae			Nassariidae
Gastropoda	Neogastropoda	Nassariidae	Nassarius	vibex	Nassarius vibex
Gastropoda	Mesogastropoda	Naticidae			Naticidae
Gastropoda	Mesogastropoda	Naticidae	Neverita	duplicata	Neverita duplicata
Bivalvia	Nuculoida	Nuculidae	Nucula	proxima	Nucula proxima
Bivalvia	Nuculoida	Nuculidae	Nucula		Nucula spp.
Bivalvia	Nuculoida	Nuculidae	Nucula	tenuis	Nucula tenuis
Bivalvia	Nuculoida	Nuculanidae	Nuculana	pernula	Nuculana pernula
Bivalvia	Nuculoida	Nuculanidae			Nuculanidae
Bivalvia	Nuculoida	Nuculidae			Nuculidae
Gastropoda	Nudibranchia				Nudibranchia
Gastropoda	Pyramidelloida	Pyramidellidae	Odostomia	bisuturalis	Odostomia bisuturalis
Gastropoda	Pyramidelloida	Pyramidellidae	Odostomia		Odostomia spp.
Gastropoda	Pyramidelloida	Pyramidellidae	Odostomia	trifida	Odostomia trifida
Gastropoda	Pyramidelloida	Pyramidellidae	Odostomia	weberi	Odostomia weberi
Gastropoda	Nudibranchia	Onchidorididae	Onchidoris	muricata	Onchidoris muricata
Bivalvia	Pholadomyoida	Pandoridae	Pandora	gouldiana	Pandora gouldiana
Bivalvia	Pholadomyoida	Pandoridae	Pandora		Pandora spp.
Bivalvia	Pholadomyoida	Periplomatidae	Periploma	papyratium	Periploma papyratium
Bivalvia	Pholadomyoida	Periplomatidae	Periploma		Periploma spp.

Bivalvia	Veneroida	Petricolidae	Petricola	pholadiformis	Petricola pholadiformis
Gastropoda	Opisthobranchia	Philinidae	Philine	lima	Philine lima
Bivalvia	Veneroida	Veneridae	Pitar	morrhuanus	Pitar morrhuanus
Gastropoda	Basommatophora	Planorbidae			Planorbidae
Polyplacophora					Polyplacophora
Gastropoda	Pyramidelloida	Pyramidellidae			Pyramidellidae
Bivalvia	Veneroida	Montacutidae	Pythinella	cuneata	Pythinella cuneata
Gastropoda	Cephalaspidea	Retusidae	Retusa	obtusa	Retusa obtusa
Gastropoda	Cephalaspidea	Acteonidae	Rictaxis	punctostriatus	Rictaxis punctostriatus
Gastropoda	Cephalaspidea	Scaphandridae			Scaphandridae
Scaphopoda					Scaphopoda
Bivalvia	Veneroida	Semelidae			Semelidae
Bivalvia	Solemyoida	Solemyidae	Solemya		Solemya spp.
Bivalvia	Solemyoida	Solemyidae	Solemya	velum	Solemya velum
Bivalvia	Veneroida	Solenidae	Solen	viridis	Solen viridis
Bivalvia	Veneroida	Solenidae			Solenidae
Bivalvia	Veneroida	Sphaeriidae			Sphaeriidae
Bivalvia	Veneroida	Mactridae	Spisula	solidissima	Spisula solidissima
Bivalvia	Veneroida	Psammobiidae	Tagelus	plebeius	Tagelus plebeius
Gastropoda	Mesogastropoda	Naticidae	Tectonatica	pusilla	Tectonatica pusilla
Bivalvia	Veneroida	Tellinidae	Tellina	agilis	Tellina agilis
Bivalvia	Veneroida	Tellinidae	Tellina		Tellina spp.
Bivalvia	Veneroida	Tellinidae			Tellinidae
Bivalvia	Veneroida	Thyasiridae	Thyasira	trisinuata	Thyasira trisinuata
Gastropoda	Pyramidelloida	Pyramidellidae	Turbanilla	interrupta	Turbanilla interrupta
Gastropoda	Pyramidelloida	Pyramidellidae	Turbanilla		Turbanilla spp.
Bivalvia	Veneroida	Veneridae			Veneridae
Gastropoda	Mesogastropoda	Vitrinellidae	Vitrinella		Vitrinella spp.
Bivalvia	Nuculoida	Nuculanidae	Yoldia	limatula	Yoldia limatula
Bivalvia	Nuculoida	Nuculanidae	Yoldia	sapotilla	Yoldia sapotilla
Bivalvia	Nuculoida	Nuculanidae	Yoldia		Yoldia spp.
					Nematoda
		Phoronidae	Phoronis		Phoronis spp.
Turbellaria					Turbellaria
					Porifera
					Priapulida
Anopla	Heteronemertea	Lineidae			Lineidae
					Rhynchocoela
Anopla	Paleonemertea	Tubulanidae	Tubulanus		Tubulanus spp.
		Golfingiidae	Phascolion	strombi	Phascolion strombi

12-3 Shad Hydroacoustic Estimate Discussion

Numbers of American Shad ascending the Delaware River has been estimated since 1975 using the Peterson capture-recapture method, Schaefer capture-recapture method, single beam hydroacoustic method, or some combination of these three techniques. Single beam hydroacoustic methods are currently employed. All methodologies, capture-recapture and hydroacoustic have been implemented with underlying assumptions. Although it was possible to account for violation of some assumptions, funding and logistical constraints prevented full exploration of assumptions inherent in capture-recapture methods used on the Delaware River. Handling and tagging sensitivity of American shad was always a concern. These concerns coupled with manpower constraints led to the adoption of more efficient and less invasive hydroacoustic methods in the 1990's by the NJFWS, with cooperation from the Academy of Natural Sciences in Philadelphia. However, hydroacoustic methods depend upon their own set of assumptions. When initially deployed on the Delaware River, estimating numbers of shad ascending the Delaware River between bridge piers on the Route 202 toll Bridge near Lambertville New Jersey was a large scale-cutting edge application of the method. The NJFWS historically spearheaded efforts to measure run size using capture-recapture methods and secured independent review of hydroacoustic methods following their initial application (Lorantas et. al. 2003). Although the hydroacoustic method appeared acceptable compared to capture-recapture methods, some improvements were suggested and made. These included:

- Extending the study until May 31 to encompass all components of the run.
- Determining the actual bottom profile of each wetted span which served to adjust the computational formula used to estimate shad within bridge span cross-sectional areas.
- Measuring American shad apparent swimming velocity on site [measured as approximately 1 meter/sec].
- Initiating count procedures earlier in the year, mid-March, in anticipation of a possible early spawning run.
- Adding an “alternative” estimator which calculated and extrapolated shad densities in more conservative fashion (1ft. – 6ft. off the bottom) as opposed to the standard calculation method (extrapolation 1ft off bottom to surface [even during high flows]).

Lorantas, et al. (2003) suggested that the hydroacoustic contractor made as accurate and precise an estimator as was possible within existing budget.

Hydroacoustic run size estimates were initially funded by the NJFWS. Subsequent collection of biological data and harvest data associated with the Delaware River run was mandated by ASMFC; consequently, the value of the work funded by the NJFWS became apparent and cooperative states shared in funding the initiative. Ultimately, biological data, harvest data, and run size data were used to assess the Delaware River stock of shad and guide future management.

As the time for stock assessment approached (2003) and levels of precision necessary to make use of data became apparent, run size estimation methodologies were reviewed in greater detail by the Cooperative. Following those reviews, needs for improved precision in the current method/technique were identified and alternative estimation methods examined. The synopsis below has been prepared by the Technical Committee to guide decision makers in selecting techniques for run size estimation useful for stock assessments. Essentially two approaches were examined. The first attempted to validate or served to correct assumptions

defined as critical in the hydroacoustic method. The second looked at a promising capture-recapture method that made use of tetracycline marked American shad in the Delaware River whose origin was from hatchery reared shad derived from restoration activities being implemented by the Pennsylvania Fish and Boat Commission on the Lehigh River and Schuylkill River.

With respect to the current hydroacoustic method, it is hoped that validation of critical assumptions or adjustments in the estimation process, associated with the validation effort, will yield an estimate with sufficient reliability to be useful in the stock assessment process. Assumptions inherent in the current hydroacoustic method were examined and those expected to have the most influence on run size (in no particular order) are:

- (1) Counted fish school signals are comprised of all American shad.
- (2) Swim speed of American shad is a constant 1m/s.
- (3) Location of American shad in the water column was is 1 foot from bottom to 6 ft from bottom, fish densities from two transducers within this region were extrapolated to the entire region.
- (4) Direction of travel is 100% upstream (no double counting).

In addition to these assumptions, specific issues associated with the time of deployment of sampling gear, potential of gear to repel American shad, pulsed movement of large schools (partially related to measurements methods) and the influence of background noise and gear threshold settings to exclude background noise were examined. In the Technical Committees judgment, with current level of understanding, these issues were not determined to have as significant an affect on the estimate as other assumptions or characteristics of the estimation process, although some influence might be expected. Validation of the above 4 items was approached with a short term focus (2 week) to limit costs. In light of the short-term approach chosen, it was obvious that real time knowledge of passage would enhance the efficiency of any validation activity. Upon review of validation methods it was determined by Lorantas et al. (2003) that the hydroacoustic camera (Didson Camera) was a device that could address most assumptions, however its availability was too limited and cost too great to consider it as near term (2003) validation method, although it reigned as the preferred validation method. Two, direct sampling methods were considered, electrofishing and gill netting. However, limited success in past attempts at gill netting and known difficulty associated with electrofishing and collecting American shad from deep water gave these techniques limited appeal in light of assumptions that could be addressed. Similarly, cost and number of assumptions validated limited appeal of the radio-tag approach. Two video camera techniques were considered and may have promise depending upon depth of field, and field of view, which would likely be dependent upon river turbidity. Although costs are reasonable, and the number of assumptions that can be addressed high, the ability to quantitatively assess and reliably assess key assumptions in consistent fashion may be limited. Log book diaries derived from fisherman whose record catch location will be used to provide a general indication that very large shad schools move past the Route 202 Bridge. Such log data is available and anglers have expressed willingness to share data to aid in characterizing the shad run. In light of the limitations and opportunities available for cost effective validation, it was made known that the USFWS-Alaska may have split beam hydroacoustic gear that could be operated concurrently with the single beam gear typically deployed in the Delaware River. The split beam gear would address some but not all assumptions of concern and likely be of less cost than the Didson Camera. Additionally, the

single beam contractor agreed to truncate the duration of the survey period by two weeks and credit the NJFWs for that period. (Lorantas et al., 2003)

Lorantas et al, 2003 noted that the contractor has endeavored to validate any concerns (assumptions and issues) the NJFWs has identified, through: (1) literature review, (2) on site-experiments and (3) observations on site within the limits of budget and equipment. However limited direct validation of the assumptions and issues identified as critical through the course of the shad run have never been completely elucidated.

Given the cost and complexity of the hydroacoustic validation approach a promising alternative capture-recapture technique was explored (Change in Ratio Method). This method made use of otolith marked American shad ascending the Delaware River following stocking in the Lehigh River as marked fry. The method examined the proportion of otolith tagged American shad in the Delaware River below the Lehigh River mouth and the proportion of otolith tagged American shad above the Lehigh River mouth. This information coupled with an exact count of American shad ascending the Lehigh River would yield an estimate of the Delaware River Run size from the vicinity of the Lehigh upriver. Unfortunately the proportion of marked American shad in the Delaware River would have to be greater than 0.05 below the Lehigh River mouth to yield a statistically reliable estimate. As noted by Lorantas et al. (2003), under current stocking levels of marked Juveniles (tetracycline mark) in the Lehigh River, the proportion of marked adult American shad returning and collected in the Delaware in assessment operations are insufficient to yield reliable results.

As reported by Lorantas et al., (2003) the short term recommendations include:

(1) Use split beam hydroacoustic techniques in conjunction with current single beam methods during shad passage times to compare resulting estimates. It is acceptable for the single beam and split beam gear to operate concurrently within a bridge pier.

(2) Fund the split beam validation technique by truncating the single beam survey such that savings can fund a short term 1 or 2 week validation effort.

(3) Step down Alternative Validation (should split beam equipment not be available)

- (a) Downrigger mounted video camera.
- (b) Mobile video camera (R.O.V.)
- (c) Electrofishing
- (d) Bottom gill net

As reported by Lorantas et al., (2003) the long term recommendations include:

(1) Do not commit to funding current single beam hydroacoustic methods until after validation activities in 2003 are complete.

(2) The Didson hydroacoustic camera was the only validation methodology that would provide definitive quantifiable answers to assumptions and issues associated with use of current hydroacoustic techniques. Deployment of the hydroacoustic camera is expensive. This technology should be explored further.

(3) Change in Ratio estimation methods was explored and application under existing stocking levels of marked American Shad will not yield reliable estimates.

(4) Explore other capture-recapture techniques.

12-4 Striped Bass Tagging Program Analysis

This monitoring report summarizes results from analyses of tagging data from the USFWS Cooperative Striped Bass Tagging Program. The results include estimates of instantaneous fishing mortality (F) and survival (S) rates. Estimates of F and S are provided with and without correction for live release bias. Also included are estimates used for model selection and model averaging, length, structure of tag releases, age structure of recaptures, geographic distributions of recaptures by month, and estimates of catch and exploitation rates by program.

Description of Tagging Programs

Nine tagging programs provided information for this report, and have been in progress for at least 10 years. Most producer area and coastal programs tag striped bass (mostly ≥ 18 inches total length) during routine state monitoring programs. Producer area tagging programs operate mainly during spring spawning, and use many capture gears, such as pound nets, gill nets, seines and electroshocking. Producer area programs are as follows: 1. Delaware and Pennsylvania (DE-PA) with fish tagged primarily in April and May; 2. Hudson River (HUDSON) with fish tagged in May; 3. Maryland (MDDNR) with fish tagged primarily in April and May, and 4. Virginia spawning stock program (VARAP) with fish tagged in the Rappahannock River during April and May.

Coastal Programs tag striped bass from mixed stocks during fall, winter, or early spring and use several gears including hook & line, seine, gill net, and otter trawl. The coastal tagging programs are as follows: 1. Massachusetts (MADFW) with fish tagged during fall months; 2. North Carolina winter trawl survey (NCCOOP) with fish tagged primarily in January; 3. New Jersey Delaware Bay (NJDEL) with fish tagged in March and April; and 4. New York ocean haul survey (NYOHS) with fish tagged during fall months. Striped bass (including those < 18 inches) are tagged during the Western Long Island Survey (NYDEC-WLI) from May through October in bays along the western end of Long Island, New York. Tag release and recapture data are exchanged between the U.S. Fish and Wildlife Service (USFWS) office in Annapolis, MD, and the cooperating tagging agencies. The USFWS maintains the tag release/recovery database and provides rewards to fishermen who report the recapture of tagged fish. Through July of 2003, a total of 403,747 striped bass have been tagged and released, with 73,663 recaptures reported and recorded in the USFWS database (Tina McCrobie, personal comm.).

Data Analysis

The Striped Bass Tagging Committee's analysis protocol is based on assumptions described in Brownie et al. (1985). The tag recovery data is analyzed in program MARK (White, 1999). Important assumptions of the tagging programs (as reported in Brownie 1985) are as follows:

1. The sample is representative of the target population.
2. There is no tag loss.
3. Survival rates are not affected by the tagging itself.
4. The year of tag recoveries is correctly tabulated.
5. The fate of each tagged fish is independent of the fate of other tagged fish.
6. The fate of a given tagged fish is a multinomial random variable.
7. All tagged individuals of an identifiable class (age, sex) in the sample have the same annual survival and recovery rates.

The analysis protocol follows an information-theoretic approach based on Kullback-Leibler Information Theory and Akaike's information criterion (Burnham and Anderson 2003), and involves the following steps. A set of biologically-reasonable candidate models are identified prior to analysis. Various patterns of survival and recovery are used to parameterize the candidate models. These models allow parameters to be constant, time specific, or allow time to be modeled as a continuous variable. Other models allow time periods to coincide with changes in regulatory regimes.

Estimates of survival

The tagging committee calculated the maximum likelihood estimates of the multinomial parameters of survival and recovery based on an observed matrix of recaptures (using Program MARK). Candidate models are fit to the tag recovery data and arranged in order of fit by the second-order adjustment to Akaike's information criterion (AICc) (Akaike, 1973; Burnham and Anderson, 1992). Annual survival rates are estimated for two size groups (fish ≥ 18 inches TL and fish ≥ 28 inches TL). Annual survival is calculated as a weighted average across all models, where weight is a function of model fit (Buckland et al. 1997). Model averaging eliminates the need to select the single "best" model, allowing the uncertainty of model selection to be incorporated into the variance of parameter estimates (Burnham and Anderson 2003). Survival is inestimable for the terminal year in the fully time saturated $\{S(t)r(t)\}$ model, so the time saturated model is excluded from the model averaged survival estimate for the terminal year only. A weighted average of unconditional variances (conditional on the set of models) is estimated for the model-averaged estimates of survival (Buckland et al. 1997).

Estimation of Fishing Mortality

For each tagging program, instantaneous fishing mortality (F) is estimated by converting the adjusted survival (S) to total mortality (Z) and subtracting a constant value ($M = 0.15$) for natural mortality, where $F = -\ln(S) - 0.15$. Using this technique, natural mortality is held fixed, and any change in total mortality (Z) results in an equal change in fishing mortality (F). Uncertainty in the estimates of F (at the 95% confidence interval) is calculated from model-averaged unconditional variances of the adjusted survival estimates. We estimate an average F for coastal programs, and a weighted average of F for producer area programs. Weights for producer area averages (based on the estimated proportion of fish contributed to the coast-wide stock, G. Shepherd, pers. comm. and D. Kahn, pers. comm.) are as follows: Hudson (0.13); Delaware (0.09); and Chesapeake Bay (0.78), with MD (0.67) and VA (0.33).

Estimation of Encounter and Exploitation Rates

In addition to estimates of S and F , we estimated annual catch rates and annual exploitation rates for three length groups (≥ 18 inch, 18-28 inch, and ≥ 28 inch) with tag recoveries of striped bass released by seven agencies (1987 - 2002) of the Cooperative Striped Bass Tagging Program.

Each time series of annual catch rates and annual exploitation rates reflects trends in fishing effort and exploitation, respectively, but do not include any assumptions about natural mortality or depend on estimates of survival. Estimates of annual catch rates and annual exploitation rates are independent among years. Fish at large for more than one year are not used in the analysis, and each tagged fish is assigned a 365-day recovery period. Consequently, recovery periods for this approach differ from those used for survival analysis,

and may influence comparisons between the two methods. Annual catch rates and annual exploitation rates are adjusted R/M ratios as described below (reporting rate = 0.43, hooking mortality rate = 0.08, R_k = killed recaptures, R_L = recaptures released alive): (1) Annual catch rate = $(R / 0.43) / M$ (2) Annual exploitation rate = $((R_k + R_L * 0.08) / 0.43) / M$

Tagging Assessment Results

Estimates of F (fish tagged and released at >= 28 inches) The 2002 estimates for producer area programs Hudson River, Delaware River, and Chesapeake Bay (HUDSON, DE/PA, MDDNR, VARAP) were 0.07, 0.33, 0.31, and 0.28, respectively, with a weighted mean fishing mortality (F) of 0.27 (Tables 18 and 19; Figure 20). The 2002 estimates of F for the four mixed-stock coastal programs (Massachusetts, New York Ocean Haul, New Jersey, and North Carolina winter trawl) were 0.05, 0.35, 0.09, and 0.27, respectively, with an unweighted-mean F of 0.19. *Estimates of F (fish tagged and released at >= 18 inches)*. The 2002 estimates for producer area programs of Hudson River, Delaware River, and Maryland Chesapeake Bay were 0.06, 0.37, 0.68, respectively.